RESTORING AMERICAN LEADERSHIP IN THE GLOBAL NUCLEAR ENERGY MARKET

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Abstract

As a result of decades of declining nuclear capability, the United States is now faced with threat of being replaced as the leader of nuclear energy. A revised approach to US nuclear energy policy would allow the US to restore its capabilities and retain its position of leadership. With a superior nuclear energy industry, the US will be able to better compete with China and Russia, its top geopolitical rivals. For that reason, the US must look at nuclear energy in new light, with an approach to policy that is not rooted in the past. The proposed policy is evaluated against a framework which emphasizes increased national security, global cooperation, US competitive advantage, and long-term viability. Based on these criteria, three critical areas of US nuclear energy policy were identified as having the best chance of restoring US prominence within the global community of nuclear energy. These areas included nuclear fuel supply chain, advanced nuclear reactor technology, and nuclear energy export. Policy that regulates each of these areas must be revised as to not allow further deterioration of the US nuclear energy industry.

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Introduction

Since President Dwight D. Eisenhower's "Atoms for Peace" speech in 1953, the United States has found itself as a leader in nuclear technology. Yet, as time has passed and challenges in nuclear energy have been faced, there has been a growing wariness of the technology. Near the end of the 20th century and into the 21st century, a renewed interest was seen across the world. While many nations with existing nuclear energy remained wary of the technology, nations with a developing need for energy saw nuclear as an answer for a reliable source of clean energy. China has experienced the largest rise in nuclear energy, constructing the majority of its new reactors in the last few decades as well as pursuing advanced next generation designs. As China's efforts have continued to increase, Russia has steadily continued its efforts in operating and developing nuclear energy as well. Russia has expanded its nuclear industry by exporting its reactors as well as nuclear fuel to developing nations. This has proven to be financially advantageous for Russia, and China also expressed a similar interest in nuclear exports. On the surface, this may seem benign, but a Russian and or Chinese led nuclear industry with have repercussions that will not only effect US national security but also global security.

With Russia and China leading the export markets for nuclear power, many nations seeking to develop or upgrade current nuclear programs will look to these nations to meet their energy needs. The US has been steadily losing its ability to involve itself with the proliferation of nuclear technology and will only continue to lose influence with each reactor exported by a foreign power. As these exports sprawl into new nations, Russia and China will gain influence within those nations that reaches far beyond the energy sector. For many developing nations, these programs are bringing low carbon emission energy

technology into regions that would have never been able to do so on their own. Nations few considered would ever have nuclear power such as Sudan, Cambodia, and Ghana among others are being offered nuclear technology. Each project gains Russia and China significant amounts of good will and new alliances. This so-called "nuclear diplomacy" is a tactic the United States must take advantage of before it loses its seat at the nuclear table to influence global nuclear policy.

This paper will examine the importance of a global nuclear energy market led by the US as well as the approach it should consider to reestablish itself as a global leader of nuclear energy. The intent is thus two-fold; first, to provide an understanding of the reasons why nuclear energy is of a national security interest to the US and secondly, to propose changes to key areas of policy to help reverse the damage from years of nuclear energy stagnation. With an established understanding of the causality of this deterioration, we can examine ways which the US can restore its status as a leader in nuclear energy. Each aspect of the proposed plan of action aims to mitigate risks against both national and global security. US leadership is essential to sustaining the standards and practices that have kept the use of nuclear energy peaceful since its conception.

Background

United States

The United States is without doubt a pioneer of the nuclear industry. It has played an integral role not only in the development of the technology but also in its responsible implementation. The US has worked with the international community to establish a culture and system of norms that has allowed for the safe and peaceful use of nuclear energy for nearly 80 years. Despite its efforts, global nuclear energy experienced a plateau in its

number of operational reactors within many western nations resulting from the disaster at Chernobyl in 1986. Nuclear energy then experienced what was deemed by some as a "nuclear renaissance" in the late 1990s through the 2000s, however, wariness of the technology was renewed again in 2011 following the disaster at Fukushima. As a result of these events the US has followed a similar trajectory in its utilization and advancement of nuclear energy, plateauing in the late 1980s with no significant advancement in nuclear technology in the last several decades. The concerns of safety around nuclear energy coupled with the rising demand for green renewable energy sources and rising cost has led to the atrophy of US nuclear capabilities. For nearly half a century, nuclear energy's most fervent critics have viewed it as a threat to the safety and security of both society and the environment.[1]

While the matter of perception is not the sole contributing factor to nuclear stagnation, the public's perception of the risks associated with nuclear energy is a significant hindrance of the advancement of nuclear energy and the most critical to overcome. Public perception of nuclear risks and policy preferences have been widely covered using several different approaches. Some have examined the issue through the lens of cultural theory, maintaining that public stances on nuclear energy have and will continue to be influenced based on underlying beliefs, values, and rationalities. The arguments that have been presented in favor of nuclear energy have been much of the same of the past, reflecting a hierarchicalist rationality, a line of rationality that is not shared by many who oppose it.[2] Those against it often can be placed in the categories of Fatalists, Egalitarians, or Individualists, exhibiting

[1] Herring,H.,2010. Opposition to nuclear power: a brief history. In: Elliott, D.(Ed.),Nuclear or Not? Does Nuclear Power Have a Place in a Sustainable Energy Future?. PalgraveMacmillan,NewYork,pp.34–50.
[2] Graaff, Shashi van de. "Understanding the Nuclear Controversy: An Application of Cultural Theory." *Energy Policy* 97 (October 2016): 50–59.https://doi.org/10.1016/j.enpol.2016.07.007.

a distrust of authority where crises are inevitable. Those who identify with these sentiments will never accept the arguments of the expert community, despite any evidence proving the benefits.

Protection Motivation Theory (PMT) has also been used to explain the relation between public perception and nuclear energy risks. "PMT proposes that awareness of a threat induces cognitive appraisal processes which activate protection motivation, leading to coping behavior aimed at removing the threat."[3] Despite the facts that the probability of accidents such as Chernobyl and Fukushima are low, large scale accidents with severe consequences can happen. Therefore, PMT argues that such an eventuality is enough for a person to adamantly oppose that perceived threat as a coping method.

Ultimately, the potential risks of nuclear energy, specifically the threat of a catastrophic failure, as well as the transport and storage of nuclear waste, have fueled the opposition. Given the nature of politics, it is public perceptions that often plays a more persuasive role in setting the priorities and agendas of regulatory bodies.[4] This speaks to why the nuclear renaissance struggled to truly gain traction, even with an increase in support for nuclear energy in the years after Chernobyl. The scientific community has failed to adequately address the fears of those who oppose the use of nuclear energy. This failure has continued to encumber the nuclear industry for half a century, only to be reignited with every critical event, such as Fukushima in 2011.

An additional factor that has led to stagnating nuclear energy in the US is related to the rise in new sources and methods of energy production. For anti-nuclear advocates, green

[3] Hartmann, Patrick, Vanessa Apaolaza, Clare D'Souza, Carmen Echebarria, and Jose M. Barrutia. "Nuclear Power Threats, Public Opposition and Green Electricity Adoption: Effects of Threat Belief Appraisal and Fear Arousal." *Energy Policy* 62 (November 2013): 1366–76. https://doi.org/10.1016/j.enpol.2013.07.058.

[4] Edwards, Michelle L. "Public Perceptions of Energy Policies: Predicting Support, Opposition, and Non-substantive Responses." Energy Policy 117 (June 2018): 348–57. https://doi.org/10.1016/j.enpol.2018.03.002.

renewable energy has filled the role of nuclear in the pursuit of carbon free energy production. Wind, Solar, and Hydro are seen as the answer to climate change by many who are ready to write off nuclear energy. Clearly, these other forms of clean energy do not pose the same risks of nuclear; it is even suggested that some residential consumers of green energy have done so to ensure their money is not supporting nuclear energy production.[5] The controversy in the US over nuclear energy has fallen victim emotion and fear rather than factual claims which have worked to the detriment of nuclear energy rather than meaningful progress in clean energy. There is a perception that energy production is zero sum where one must choose nuclear over alternative energy sources. This fallacy has led many to believe nuclear is anti-green renewable energy. However, this is not the case, a rise in cheap natural gas along with other existing coal and oil burning plants are the greater competitors of nuclear. Falling costs of traditional high emission energy production has given way to a resurgence in recent years with the use of fracking and discovery of new natural gas reserves in North America. Nuclear plants are being shuttered but not in favor of wind and solar, but for natural gas burning plants with little condemnation by the American public.

While nuclear energy continues to struggle in the US and elsewhere in the west, there has been a surge in interest and demand in other parts of the world. With economic growth in new regions of the world comes the need for increased energy production to support these emerging economies. In addition to the 440 existing reactors around the globe, there

[5] Hartmann, Patrick, Vanessa Apaolaza, Clare D'Souza, Carmen Echebarria, and Jose M. Barrutia. "Nuclear Power Threats, Public Opposition and Green Electricity Adoption: Effects of Threat Belief Appraisal and Fear Arousal." *Energy Policy* 62 (November 2013): 1366–76. https://doi.org/10.1016/j.enpol.2013.07.058.

are 55 reactors currently under construction across 15 countries.[6] To further highlight the fact that nuclear energy is of global interest, there are an estimated 30 countries that are currently considering, planning or commencing nuclear power programs, with an additional 20 or so that have expressed interest in developing nuclear programs of their own.[7] With diminishing innovation in nuclear technology and a limited history of nuclear energy exports, the US is not well positioned to involve itself in new nuclear nations.

China

These aspiring nuclear nations will need to rely on the expertise of outside nations, and it is here where state owned corporations in China and Russia have taken the lead. The majority of these nations are in the Middle East and South East Asia, causing many to look to China as a model. China's rapid growth over the past several decades and their commitment to nuclear energy to meet their energy needs while reducing their heavy emissions is a path these nations wish to follow. With 48 reactors in operational status and another 15 under construction, China is quickly approaching US nuclear energy production capabilities.[8] China has drawn much of its nuclear technology from western nations such as France, Canada, US, as well as Russia, and has been adapting and developing improvements as the need for more reactors grows. Based largely on plans of US and French design, China has developed its own reactor of which it owns the intellectual property and is therefore free to export. China has made significant strides in another

[6] *Plans for New Nuclear Reactors Worldwide* - World Nuclear Association. (2020). World-Nuclear.Org. https://www.world-nuclear.org/information-library/current-and-future-generation/plans-for-new-reactors-worldwide.aspx

[7] *Emerging Nuclear Energy Countries* | New Nuclear Build Countries - World Nuclear Association. (2020). World-Nuclear.Org. https://www.world-nuclear.org/information-library/country-profiles/others/emerging-nuclear-energy-countries.aspx

[8] "China Nuclear Power | Chinese Nuclear Energy - World Nuclear Association." World-nuclear.org, 2020. https://www.world-nuclear.org/information-library/country-profiles/countries-a-f/china-nuclear-power.aspx .

critical aspect of nuclear energy; it has become largely self-sufficient in most aspects of its fuel cycle. While currently still relying on some foreign suppliers, China is working towards its goal of producing one-third of its needed uranium domestically, one-third from Chinese foreign mines and one-third from open markets.[9] Securing its supply chain for not only fuel but materials and processes needed to build reactors has situated China as a leader in nuclear energy.

Once China has fully satisfied its domestic priorities as set by its national policy, its ability and desire to export nuclear technology will continue to increase. China has expressed openness to a number of different operating models including everything from engineering and procurement to owning and operating foreign reactors. The push to export their technology has steadily increased over the last decade reaching a peak in 2015 with the new incentives to finance nuclear projects following $103 billion outboard trade and investments in 2014 and again in 2017 with the formal launch of their Belt and Road Initiative (BRI).[10] Although gaining access to established nuclear markets such as the US, Japan, or Russia is highly unlikely, the United Kingdom and France may offer more opportunities for Chinese exports. China is working to gain access to these markets as it would advance the credibility of their technology further establishing them as a leader in nuclear energy.

The geopolitical intentions are not hidden behind China's increased nuclear involvement abroad. It has framed its push for increasing its own domestic nuclear energy production as a war against climate change, but China's global influence goals should not

[9] "China's Nuclear Fuel Cycle - World Nuclear Association." World-nuclear.org, 2020. https://www.world-nuclear.org/information-library/country-profiles/countries-a-f/china-nuclear-fuel-cycle.aspx.
[10] "China Nuclear Power | Chinese Nuclear Energy - World Nuclear Association." World-nuclear.org, 2020. https://www.world-nuclear.org/information-library/country-profiles/countries-a-f/china-nuclear-power.aspx .

be ignored. Exporting nuclear energy creates a link to China that many nations will be locked into for decades. With each reactor exported or project financed Beijing has intertwined itself within a critical element of growing nations' energy production which it will rely on to support its growing economy. China's current reactor construction accounts for more than half of global nuclear growth, exporting to various nations such of which are allied with the west as well as nations that are not member of the Nuclear Non-Proliferation Treaty.[11] It is for this reason the concerns over nuclear proliferation have been raised. China is setting itself apart from every other nuclear exporting country, sans Russia, using nuclear energy projects as a geopolitical tool, expanding its level of influence and power in regions it currently operates in and creating new ties to regions that have traditionally been outside its sphere of influence.

Russia

While China has been strengthening its domestic nuclear ability with the hopes of increasing its global expansion, Russia has been steadily increasing its nuclear energy exports. Despite being responsible for the worst nuclear disaster in history, Russia has remained active in the nuclear energy space, re-emerging with a new design after a 20-year lull. Unlike many western nations, Russia has continued its efforts to advance and export nuclear through its state-owned corporation, Rosatom. As a result, Russia finds itself as the leading exporter of nuclear energy. Rosatom's exports of reactors have nearly tripled since 2011, their confirmed export orders comprise 60 percent of the overall market and a quarter of Russia's own GDP totaling $330 billion.[12] These plans span the globe, from the Middle

[11] Cho, Il Hyun. "Going Nuclear: The Promises and Perils of Nuclear Energy in China." Political Science Quarterly 135, no. 3 (September 2020): 439–65. https://doi.org/10.1002/polq.13069.
[12] Holgate, Laura S. H., and Sagatom Saha. 2018. "America Must Lead on Nuclear Energy to Maintain National Security." Washington Quarterly 41 (2): 7. doi:10.1080/0163660X.2018.1484223.

East to South America, highlighting the global reach and, more importantly, influence Russia has been able to attain. Similar to China, Russia considers nuclear energy exports a key element of its foreign policy. Signing nuclear deals with developing countries has allowed Russia to bolster its international image by playing the benevolent supporter of rising nations while situating itself to reap the benefits of its goodwill in the future.

Russia has already displayed its willingness to exploit its natural gas exports in Europe as it dominates the market with no viable competitor. There is little reason to think it will not act in such a manner in its nuclear energy exports as well. A major reason Rosatom has become so dominant in the market is because of its Build, Own, Operate offerings. This lowers the barriers to entry significantly for developing nations. As such it an enticing option to purse a nuclear relationship with Russia over any other nation. Under this scheme, Russia's Rosatom manages everything from the fuel needed to the building and operation of the reactor to the management of spent fuel, while also financing 49-90% of the project.[13] The dependency this creates on Russian resources and expertise in unparalleled by any other form of energy export. The existence of such a dependency will undoubtedly be used as tool of political coercion. The leverage Russia is able to exercise over more established nations of Europe will pale in comparison to the leverage it will have over developing nations in Africa and more importantly for the US or South America. The issue is compounded by the fact that nuclear power carries far higher and lasting consequences than natural gas pipelines if poorly managed. Russia will be far more integrated into nations that rely on it for nuclear material and expertise. This integration will give Russia a greater ability to manipulate agendas for geopolitical gain with the implication of a threatening a

[13] Ibid

nations energy supply. Such behavior has been seen with Hungary. Russia has assisted Hungary advance its nuclear ability considerably to achieve over half of its energy production from nuclear energy. As a result, the Hungarian government has been openly thankful for the support of the Russian government and has called for the EU to end its sanctions and normalize relations with Russia.[14] With Rosatom contracted to construct reactors in nearly 30 countries, it is not hard to imagine similar scenarios unfolding. Nations that have traditionally been friendly or even allied with Western powers are severely limited in their options for pursuing nuclear energy production. As such, their desire to gain access to a clean and reliable mean of energy production may reasonably outweigh their wariness for a nation such as Russia or China. However, once China or Russia gain access to new governments, either with financing, construction, or operation, these US adversaries will have an extremely effective means of destabilizing traditional allies and spheres of influence.

Aside from the obvious concerns of Russia and China becoming involved with allied nations in a critical sector, there is the large concern of safety and regulation of nuclear power. As China advances its domestic ability and gains traction with its latest nuclear technology, Russia will gain a real competitor with the business of nuclear export. Each country has already shown its willingness to export to any nation with some amount of capital and an interest to construct. With a shrinking market size, each nation will become more likely to export to nations the US would much rather remain non-nuclear. As mentioned, both countries have or have plans to export technology to Africa, the Middle East, and South America, to include nations such as Yemen, Rwanda, Cuba, and Venezuela

[14] Ibid

to name a few. All of which have questionable track records of stability and would pose a significant threat should they gain access to nuclear materials and reactors that are regulated and operated beneath US standards.

The US finds itself in a world where nuclear energy is on the rise and being promulgated by its two largest adversaries. Yet, it also finds itself engaged in an internal debate over the future of nuclear energy. Much of the American public sees this issue as one of domestic safety and environmental concern and fails to place the matter within the larger context of national security. This is likely due to the fact that great power competition is not seen as a top priority by the American public as shown by recent polling.[15] This polling is reflective of the misconception that the geopolitical chess matches of the Cold War are of the past, developing nations are not pawns to be won but nations free to decide their own fate. However, that is not reflective of the world that is being shaped by Chinese and Russian policies of predatory lending and aggressive exporting of nuclear power to nations that may be entirely unsuited to responsibly utilize such technology.

Current US Policy

The US government has continued its involvement in commercial nuclear energy from its inception to present day. Nuclear energy has the most extensive requirements and review processes of any other industry in the US. While the views on nuclear energy have become more favorable in the present day, the policy that will allow the industry to thrive has been slow to develop. President Barack Obama, as well as President Donald Trump, have both expressed interest and encouragement in advancing the nuclear industry but it

[15] Gattie, David K., and Joshua N. K. Massey. 2020. "Twenty-First-Century US Nuclear Power: A National Security Imperative." *Strategic Studies Quarterly* 14 (3): 122–43. http://search.ebscohost.com.proxy1.library.jhu.edu/login.aspx?direct=true&AuthType=ip,shib&db=tsh&AN=145916987&site=ehost-live&scope=site.

has largely ended with rhetoric. Nuclear energy policy can be divided into four relevant areas of focus, fuel production, operation, waste management and import-export regulation. A healthy nuclear energy industry will have effective policy across all four of these areas. In order to demonstrate the impact that the rise of nuclear energy will have on national security, this paper will focus on fuel production, operation, and import-export regulation will be the priority.

Despite growing interest domestically and abroad, US policy has done little to ensure US advancement or competitive advantage in the industry. Over the last two decades, there have been three notable pieces of legislation that have passed into law supporting nuclear energy, the Energy Policy Act of 2005 (EPA), the Advanced Nuclear Technology Development Act of 2017(ANTDA) and Nuclear Energy Innovation and Modernization Act of 2019 (NEIMA). The most substantial of these being the EPA of 2005, which was revised by the Nuclear Energy Innovation Capabilities Act of 2017. The EPA has allowed for production tax credits of 1.8 cents/kWh for the first 6000 MWe produced, federal risk insurance of $2 billion, and federal loan guarantees for advanced nuclear reactors for up to 80% of the project cost.[16] The EPA has been in effect for nearly 15 years, while it is a step in the right direction, there has still been little advancement within the US. Only two reactors have started construction despite the efforts to make it more advantageous for utility companies and innovators are still forced to seek foreign help to test new designs.

[16] "H.R.6 - 109th Congress (2005-2006): Energy Policy Act of 2005." Congress.gov, 2020. https://www.congress.gov/bill/109th-congress/house-bill/6?q=%7B%22search%22%3A%5B%22%5C%22nuclear+energy%5C%22%22%5D%7D&s=2&r=40.

Congress has taken the important first step in tasking the Nuclear Regulatory Commission (NRC) with streamlining the licensing and regulatory process with the passing of ANTDA and NIEMA. After a four year process, the NRC, in conjunction with Department of Energy (DOE),has just recently completed its Licensing Modernization Project, which aimed to specifically address licensing barriers in advanced reactor concepts.[17] This has led to a better suited framework of regulation for advanced reactors that had historically been held to the ill-fitting regulations of traditional light-water reactors. This legislation is still a shortfall as it offers a simplification of a process that has become bloated rather than offering an incentive for future investment in the industry.

As of October 2020, although discussed by industry experts for years, a uranium reserve has yet to be established even though the Trump administration has expressed interest in doing so and has requested funds to do so in the fiscal year 2021 budget. However, Congress has asked for more information on how the DOE plans to establish the reserve and what the program implementation would be, further delaying the process. In regard to the remainder of the fuel process, no plan has been put forward to correct the lack of US conversion or enrichment ability of nuclear material, nor its inability to manufacture key components of reactors such as pressure vessels. All of which leaves the US vulnerable and dependent on imported material for its nuclear fuel needs.

Additionally, the NRC regulation that controls export and import of nuclear material has remained unaltered and is considered by commercial nuclear companies to be a major competitive disadvantage. The regulations are a remnant from a time when nuclear energy was guarded as a national secret. Times have changed since the early days of nuclear

[17] "Licensing Modernization Project for Advanced Reactor Technologies: FY 2018 Project Status Report," 2018. https://inldigitallibrary.inl.gov/sites/sti/sti/Sort_7242.pdf.

energy. Today nuclear technology is widely accessible, yet commercial companies find themselves having to navigate a complex and difficult set of licenses and authorizations. This complexity makes the US less efficient than its competitors and ultimately causes prospective customers to pursue other non-US options.[18]

It is important to note that the US is no longer actively looking away from nuclear energy. The legislation mentioned so far is proof that policymakers are interested in the topic and wish to make advances. However, progress has been slow, and the true impact of these efforts is that they have merely gotten the US out of the red and back to zero. To get ahead of its competitors, the US needs to allow existing companies to operate with greater ease, and work to incentivize innovation within the US. Policy makers may support these ideas, but the current policy does not. No policy exists to bolster the front-end fuel supply process. Advance reactor technology is not supported to the degree it should be,. Lastly, protective export controls are from the past and are further limiting commercial nuclear companies from expanding US influence in this critical sector of industry.

Policy Proposal Overview

The aim of this proposal is for the US to regain its status as the world leader in nuclear energy for the purposes of increasing its national security. To better counter the actions of China and Russia in this critical sector, the US must commit to a full backing of nuclear energy, both within the public and private sector. Although this would be no small undertaking, such proposals have already fostered bipartisan support, paving the way for a more aggressive approached when framed in the context of national security. There are

[18] Glasgow, James, Stephen Pillsbury, Winthrop Shaw, and Pittman Llp. "NUCLEAR EXPORT CONTROLS INTRODUCTION: PURPOSE OF THIS ASSESSMENT," 2012. https://www.pillsburylaw.com/images/content/3/3/v2/332/NuclearExportControls.pdf.

several ancillary benefits that such actions will yield, but these benefits are not the priority of this plan. There are three main areas of nuclear energy the US must set out to regain its supremacy in to adequately challenge the efforts of China and Russia.

Restoring the fuel supply chain, specifically the front-end of the nuclear fuel cycle, should be set as priority number one. The front-end of the fuel cycle consists of four steps, mining, conversion, enrichment, and fabrication. In 2019, the US produced the lowest amount of uranium concentrate since 1949, an 89% decrease from 2018 alone.[19] At the start of the atomic age the US government introduced a slew of incentives and advantageous trade policies that allowed the uranium mining industry to thrive. With the end of many of those incentives and polices in the 1980s mining, as well as the subsequent processes of conversion, enrichment, and fabrication, dwindled as well. As a result, the US has become extremely dependent on imports for its nuclear fuel, importing nearly 75% from foreign nations.[20] US capabilities for conversion and enrichment offer no upside to this process either. Currently, there is only one facility in the US capable of converting uranium concentrate to feed material that can be enriched; however, it had not produced any such material since 2017 and was closed in a "ready-idle" status since 2018.[21] Similarly, there is one enrichment facility in the US that is operable but uses outdated technology. The combination of these facts highlights the extreme vulnerability US nuclear energy faces. With a robust industry for front end fuel cycle processing the US can push

[19] "2019 Domestic Uranium Production Report," 2020. https://www.eia.gov/uranium/production/annual/pdf/dupr2019.pdf.
[20] "Section 232 Investigation: Uranium Imports," 2019. https://fas.org/sgp/crs/misc/IN11145.pdf.
[21] "Conversion - World Nuclear Association." World-nuclear.org, 2020. https://www.world-nuclear.org/information-library/nuclear-fuel-cycle/conversion-enrichment-and-fabrication/conversion-and-deconversion.aspx

ahead of its competition offering security for domestic energy production and become a top supplier of nuclear fuel globally.

Equally important to improving the front end of the nuclear fuel cycle is establishing the US as the unequivocal leader of next-generation nuclear technology. Where Russia and its allied partners have led the globe in uranium production, China is taking the lead in advanced reactor technology. The US still serves as the birthplace for the conceptualization of next-generation concepts; however, the concepts are being taken to China for testing as there is a lack of funding for research and development within the US. This is highly problematic. In 2017, The National Bureau of Asian Research reported that the US has suffered over $1.2 trillion in economic damage as of 2014 due to counterfeit goods, pirated software and theft of trade secrets and intellectual property (IP) and endure an estimated $600 billion loss annual from IP theft alone.[22] US based research teams that have been forced to turn to China to test and further develop their designs have been forced to agree to terms which are highly in favor of the Chinese owned companies they must partner with. The US should not only increase the budget of the Department of Energy but revise aged policy to incentivize private industry, both foreign and domestic, to invest in research reactors to keep these advanced technologies within the US.

As the US makes strides in improving the front-end processes of fuel supply chain and works to support advance reactor technology, the focus should then be turned to exporting the technology. The US currently finds itself as an observer to a nuclear market which it is responsible for creating. The lack of US presence in the nuclear energy export market presents two threats. Most importantly, it threatens the diplomatic relationships

[22] "IP Commission Report," 2017. The National Bureau of Asian Research. http://ipcommission.org/report/IP_Commission_Report_Update_2017.pdf

with nations that are now turning to Russia and China for nuclear material and expertise, thus negatively impacting geopolitical relations. Secondly, the US will find itself unable to mandate security and non-proliferation standards which it has spent decades to establish. If the US does not propel itself to a leader of this market, then Russia and China will be left to dictate the level of necessary standard. As market size shrinks and competition increases, the requirements for developing nations wishing to obtain nuclear energy will likely diminish. China has already shown this as a likely outcome as it has entered into agreements with Nuclear Non-proliferation Treaty (NPT) members. Creating an export program will not only provide an economic benefit to the US and its industry, but it will also help to keep the balance of geopolitical influence in order and mitigate potential risks to US national security.

Policy Evaluation Methodology

When discussing the topic of nuclear energy there are a few terms that should be defined to avoid confusion. The first of those terms is security, this can be divided into two more specific terms which have some overlapping meaning but should be understood as two distinct ideas. National security, the more obvious and well-known term regarding security. In the context of this paper, national security should not be thought of in the traditional military sense of a physical attack, but rather the ability of the US to protect its interests and alliances abroad. A nation's ability to project its influence and power is directly related to its national security. If the US continues to be challenged by its adversaries on the topic of nuclear energy it exposes a vulnerability in its ability to exert influence abroad thus further compromising national security. Whereas national security is concerning itself to maintaining global balance, energy security relates to domestic

security. Often considered a subset of national security, energy security as defined by the International Energy Agency (IAE) is, "the uninterrupted availability of energy sources at an affordable price." [23] Energy security stresses the duty a nation has to ensure reliability and access to energy for its citizens. This means a nation's access to energy should be free from foreign influence and nations should continuously seek to reduce vulnerabilities in its supply chain and its power grid operation.

To adequately evaluate any policy approach, a set of guidelines must be put in place that help to establish a baseline of what an advantageous approach should aim to achieve. The specifics of any proposed policies will surely be argued, it is for that reason these guidelines are comprised of several broader cornerstone elements of nuclear policy that should be considered necessary to set forth a successful nuclear policy.

First, does the policy increase the security of the US, both national security and energy security? The US should continue to minimize its vulnerabilities wherever it can, this does not end with the topic of energy production especially that of nuclear. As mentioned previously, nuclear energy is of global interest and a growing arena which great powers will look to exert influence and maintain globe balance which leans in said nations favor. An exceptional policy recommendation will focus on reducing the dependence of the US on foreign nuclear fuel and will allow for an increased competitiveness in the global market.

Second, does the policy allow for and encourage global cooperation to better meet the needs of advancing nuclear energy? A policy that focuses on solving the challenges of nuclear domestically is restricting itself by its very nature. It is important that no

[23] Energy security – Topics - IEA. "Energy Security – Topics - IEA." IEA, 2020. https://www.iea.org/topics/energy-security.

dependencies are allowed to grow with increased cooperation. The resources and knowledge base from other countries should be utilized to the benefit of all nations involved, no one nation is depending on another to solve a given issue. Equally important is the reverse, no one nation should refuse to share information or believe it must solve certain issues without the help of foreign aid.

Third, does the policy work to achieve US competitive advantage for commercial nuclear energy companies? While funding is critical to advance technology, companies will still be limited by the rules and regulations which govern their ability to develop and sell nuclear technology. An exceptional policy encourages regulatory agencies to reevaluate standing guidelines and regulation. Adding new regulation often leads to added complexity and will do little to help advance timelines of licensing and approval that currently yield delays and added cost to nuclear projects. The policy should not compromise the values of nuclear energy, but regulation should not needlessly slow companies down especially in a market where other state-owned enterprises are pulling away from US commercial companies.

Finally, does the policy have long term viability? This requirement is perhaps the most difficult as it requires foresight of an industry that is ever changing. While the policy should aim to solve the immediate problems the US faces in nuclear energy, it should not do so at the expense of sustainability. Increasing national and energy security, fostering global cooperation, and supporting the advancement of relevant technology will have a diminished effect if they are not enacted in manner that can survive across different administrations over several decades. In addition to the survivability of the plan, it must also be sustainable in practice. Advancing and expanding our nuclear capability is only one

part of the process that must be address. Dealing with the byproducts of nuclear energy production is the most crucial aspect that will determine the sustainability. While it is important for a policy to address the more immediate concerns, it will also require a feasible plan for waste management.

Should a policy meet these four criteria it would be reasonable to assume a high probability of success of increase national security and a restoration of nuclear leadership. The evaluation will look at the proposals grand strategy rather than focusing only on individual programs or actions. The policy should be all encompassing to include several aspects of nuclear energy, evaluating the proposed actions as a system. A policy comprised of actions with seemingly little or random direction should be seen as unsatisfactory. Instead, we should see actions that feed into the proceeding steps resulting in a compounding effect to maximize US capabilities and leadership in nuclear energy.

Policy Proposal

Starting with a broad view of the topic allows for the most important and pressing aspects of nuclear energy, as it relates to regaining global leadership, to come to the surface. While maintaining the current fleet of US nuclear reactors and improving waste management of spent fuel are both relevant, excelling in these two areas of nuclear energy will do little to position the US as a global leader in nuclear energy. It is for that reason that maximum effort should be focused on areas where the US can directly challenge China and Russia and most improve its national security. The broader areas of nuclear fuel supply chain, advanced reactor technology and exporting serve as only as an explanation of what the US must do. In order to adequately prove the advantages of this approach over the current approach, a specific outline of this approach should be examined.

Nuclear Fuel Supply Chain

Improving the front end of the nuclear fuel cycle would achieve two important tasks. It first would decrease the level of foreign dependence for the fuel needed to run current US reactors thus increasing US energy security. Secondly, an improved fuel process can be utilized to challenge Russia as Russia and its allies, mainly Kazakhstan and Uzbekistan, produce nearly half of the world's uranium. Russia has worked to solidify its relationship with the two nations by signing joint venture deals for intergovernmental cooperation on nuclear energy. As mentioned, the front end of the fuel cycle is divided into four parts: mining, conversion, enrichment, and fabrication. The first three parts of this cycle must be the focus, as the US currently maintains an ability to fabricate fuel with the operational status of three facilities but is severely limited in the remaining three areas.

In order to revive the mining of uranium, the US must first provide the incentive for private companies to do so. It is for that reason the US should begin a policy of direct purchasing of uranium from domestic mines for the purpose of establishing a uranium reserve. With competitive procurement actions for uranium, similar to those actions that resulted in a boom in uranium mining from 1947 through 1970, private companies will be guaranteed a market for their product. To further incentivize private mining of uranium, once the establishment of the reserve is complete, uranium exports should be permitted to assure the mining industry there will continue to be a market for their uranium. The sale of uranium should be limited to direct sale to the US government as well as private domestic use for US utility companies. Foreign sale should not be permitted without the existence of an adequate reserve which has been estimated by the Department of Energy's Nuclear Fuel Working Group (NFWG) to be an additional 17 to 19 million pounds of

uranium ore.[24] These procurement actions should be reminiscent of the policies set by the Atomic Energy Commission (AEC) originally established in 1947. Agreeing to guaranteed ore prices at set quantities will give the industry the assurances it needs to purse the exploration and production of uranium ore in the US. While it should remain as consistent as possible the procurement actions should be allowed to fluctuate to control the market. We saw this in 1962 when the AEC decided to stretch out its current procurement program after it recognized the private market would not sufficiently sustain a viable domestic uranium industry.[25] Although the AEC was extremely successful at growing an industry from nothing, it teaches the importance of developing an industry with the help of government procurement but not with a dependence on it.

Along with establishing an industry for uranium mining, the proceeding two steps in the front end of the fuel cycle should be given similar attention. Without the means to complete the remaining steps the of fuel creation process, the mining of ore is irrelevant in terms of increasing US national security. The US currently has no means of converting ore into feed material and only has the ability to produce approximately one third of the nation's annual reactor requirements from a single commercial enrichment facility.[26] This portion of the plan is more domestically focused as it requires an assurance of a market for the product that will eventually be produced. It is for that reason the current US nuclear fleet of reactors should be maintained and granted license to extend operation rather than

[24]Restoring America's Competitive Nuclear Energy Advantage

[25] Albrethsen, Alger, and Frank Mcginley. "GJBX-220(82) SUMMARY HISTORY 0 DOMESTIC URANIUM PROCUREMENT UNDER U.S. ATOMIC ENERGY COMMISSION CONTRACTS INAL REPORT," 1982. https://mountainscholar.org/bitstream/handle/11166/85577/cogjm.Sum_Hist_Domestic_Uran_Procure_US_Atomic_Energy_Comm_Contracts_Final_Report_Oct_1982.pdf?sequence=1.

[26] "The Front End of the Nuclear Fuel Cycle: Current Issues," 2019. https://fas.org/sgp/crs/nuke/R45753.pdf.

force these reactors to close prematurely. The Federal Energy Regulatory Commission (FERC) can help to put nuclear energy on an equal playing field to other methods of energy production by supporting wholesale of material as well as price formation in many of the deregulated markets these reactors operate in.

The secondary issue with the conversion and enrichment process is the lack of facilities. With no operational conversion facility in the US and only a single enrichment facility, there is no real solution to this challenge outside of encouraging companies to open the needed facilities. This is not a complex challenge to solve, but there are limited ways in which the US can confront it. The common solution as presented by the NFWG and others is to reduce the regulation constrictions on companies and facilities that partake in these processes. There should be no diminishing of safety standards or other reduction in regulation that would have negative impact on the industry. However, after several decades of developing nuclear energy and policy makers learning how to best ensure safety, an excessive amount of bureaucracy and red tape has resulted in delays and increased costs. These costs are then passed on to consumers of nuclear fuel, thus increasing the cost and viability of nuclear energy.

Similar to the challenges in establishing a robust uranium mining industry, conversion and enrichment would be better suited with less restrictive export regulations. Regulations on where nuclear material can be exported should be revised to enable sales to friendly or even low risk nations. Additionally, any quantity restrictions should be reevaluated to allow for a reasonable level of exports to any one nation. These revisions should begin immediately, as it will take time for such changes to go through proper channels. In that time a building of a reserve of both uranium ore and enriched fuel can be

established. If such revisions are to happen quicker than anticipated the change should not be in effect until these reserves are established.

Advancement of Reactor Technology

The importance of improving the fuel supply chain rests on the fact that the 90 plus reactors currently in operation within the US will require uranium fuel to continue their operation. With current reactors able to operate with increased security in fuel supply and potentially even lower costs, focus and resources should be shifted to the development of next generation advance reactor technology. The importance of developing advanced next-gen technology is twofold. Most importantly is that with US leadership into this new generation, the US will set the standards for quality and safety as they have since the technology's inception. Secondly, in the marketing industry there is the idea of first-mover advantage. This is the idea that there is an advantage to the party that is able to bring a new product to market first. It establishes strong recognition as well as additional time to correct and improve as needed. This often results in the first product to market standing the best chance of success over its competitors. Developing next generation reactors first means giving the US commercial nuclear industry a sizable advantage against its state sponsored competition.

The cost of the development of these next generation reactors cannot be ignored. It is unrealistic to expect private industry to commit the level of investment needed to develop such technology. Even so, for any one nation to bear the brunt of the cost would be a heavy toll. We see this in China now who is leading the development of next-gen reactors, although exact figures are unknown, China has invested considerable resources to its development of these reactors. The Shanghai Institute of Applied Physics which works

under the auspices of the Chinese Academy of Sciences has 700 nuclear engineers working on its advanced reactor program.[27] No other nation comes close to matching this level of commitment. While they are close to having a demonstrator reactor it has taken a decade to get to this point with superior investment. China's progress should give policy makers an elevated sense of urgency in the matter of developing this technology.

The US DOE has recently announced its plans for an Advanced Reactor Demonstration Program (ARDP) that aims to expedite the development process by teaming with private industry. To compete with the state sponsored industry of China and Russia, this is an important first step, but it is not an aggressive enough change in policy to close the growing gap between US and Chinese development. To not only catch up to Chinese efforts but surpass them, the US should look to partner with allied nations. The best option would be to collaborate with nations that have a need or expressed interested in developing such advanced reactor technology. Canada and the United Kingdom both operate an aging fleet of non-light water reactors of non-US origin. The UK operates a fleet of gas cooled reactors that are expected to go offline in the next decade and Canada maintains a fleet of heavy-water reactors which it has considered replacing with new light water or other advanced concept designs.[28] For that reason, Canada and the UK stand to be ideal partners for such a program as they are close allies, they would benefit from the resulting technology, and are not likely to be competitors in the nuclear industry market. This is not

[27] Martin, Richard. "China Details Next-Gen Nuclear Reactor Program." MIT Technology Review. MIT Technology Review, October 16, 2015. https://www.technologyreview.com/2015/10/16/165755/china-details-next-gen-nuclear-reactor-program/.

[28] "Columbia SIPA Center on Global Energy Policy. Strengthening Nuclear Energy Cooperation between the United States and Its Allies." Columbia.edu, 2020. https://www.energypolicy.columbia.edu/research/report/strengthening-nuclear-energy-cooperation-between-united-states-and-its-allies.

to say partnership would be limited to these nations. For instance, Japan, the Republic of Korea and France would also add significant value to such a program. However, each of these nations are nuclear exporters in their own right and may view the US initiative as a threat to their own intellectual property and finished products.

To establish such a cooperation, the US must revise a specific statue that was incorporated in the Atomic Energy Act (AEA) of 1954 that has stood for nearly 70 years. Section 103d of the AEA states:

"No license may be issued to an alien or any corporation or other entity if the Commission knows or has reason to believe it is owned, controlled, or dominated by an alien, a foreign corporation, or a foreign government. In any event, no license may be issued to any person within the United States if, in the opinion of the Commission, the issue of a license to such person would be inimical to the common defense and security or to the health and safety of the public." [29]

This statute has left both the NRC and the nuclear industry with a vague yet restrictive requirement that has served as a major barrier to foreign cooperation and investment in US nuclear industry. A joint program for advance reactor technology would require both manpower and investment to expedite progress. However, as the statute is currently interpreted no foreign entity can apply for a license to operate a reactor within the US, nor can a company that is owned by a foreign entity indirectly own or control reactors within the US. At the dawn of the nuclear industry, such a statute is understandable, but in today's

[29] "NRC: Foreign Ownership, Control, or Domination (FOCD) of Commercial Nuclear Power Plants." Nrc.gov, 2013. https://www.nrc.gov/reactors/focd.html#:~:text=Section%20103d%20of%20the%20Atomic,corporation%2C%20or%20a%20foreign%20government.

age where nuclear technology and supply chains are global, and the corporate landscape is multinational, such regulation makes for an intricate labyrinth of legal barriers.

Major companies in nuclear energy are often subsidiaries of or have significant involvement with foreign entities. For example, Westinghouse which is owned by a Brookfield Business Partners from Canada or GE-Hitachi Nuclear Energy which is a joint global alliance between US and Japanese companies. As indicated by new legislation introduced in recent years, there is a rising interest from Congress to develop innovative reactors that are both safer and less costly. Congress should continue down its path of interest, starting with revising the AEA to encourage and promote seamless relationships with nations which would allow for reduced costs as well as a reduction in the expected timelines of operational next generation reactors. Some stipulation would need to be determined for qualified partners, a starting point should be with nations that are with the Five Eyes community or those nations that have an existing mutual defense agreement with the US.

Export Program

Developing advanced reactor technology will not only benefit the developing nations, but it has ancillary benefits when it comes to exports and nuclear market competition. Each of the first two steps benefit the US in their own way, but on a more strategic scale, they bolster the US commercial nuclear industry, ultimately paving the path to supremacy in nuclear energy. Currently, Russia is the leading exporter of nuclear reactors. As of 2018, Russia has exported 39 reactors spanning around the globe, doubling

China, which comes in second place, exporting 15 reactors.[30] While leading the nuclear export market, Russian exports are all of older and simple designs utilizing pressurized water concepts. Many of the additional orders it has on its books are of similar design and it is important to note that none of these new projects have begun construction as of 2020. There is speculation on whether Russia or partnering nations will be able to follow through with these orders, but regardless, Rosatom currently has the potential to construct 33 new plants worth a total of $130bn.[31]

To better compete with Russia and soon China in the global export of nuclear energy, the US should look to how its competitors are bolstering nuclear exports. Russia, Japan, and the Republic of Korea have all adopted a modern export process where a single agency is tasked with licensing and setting requirements for export. The US currently has four agencies that each have their own sets of regulation and process for review: the Department of Energy, Department of State, Department of Commerce, and the Nuclear Regulatory Commission.[32] The US must streamline this process and cut out unneeded bureaucracy that complicates and delays the process. Interested parties will seek to fill their energy needs with competitors if they believe the required licensing will delay and increase project costs. A review of the processes each agency carries out should be conducted to minimize redundancies creating a licensing framework that incorporates the most pertinent aspects of each agencies review process. Once established, a review board comprised of

[30] The Economist. (2018, August 7). Russia leads the world at nuclear-reactor exports. The Economist; The Economist. https://www.economist.com/graphic-detail/2018/08/07/russia-leads-the-world-at-nuclear-reactor-exports

[31] Ibid

[32] Glasgow, James, Stephen Pillsbury, Winthrop Shaw, and Pittman Llp. "NUCLEAR EXPORT CONTROLS INTRODUCTION: PURPOSE OF THIS ASSESSMENT," 2012. https://www.pillsburylaw.com/images/content/3/3/v2/332/NuclearExportControls.pdf.

members of each of the mentioned agencies can be established. The DOE should serve as the lead agency in charge of the review board and be the agency responsible for issuing the final license to export. Introducing timelines would serve as an additional benefit to this process. With redundancies reduced and less time needed for multiple agencies to review applications, reasonable timelines should be placed on the process to ensure accountability and timelines. Several exporting nations do this currently, Japan, Republic of Korea and Russia all impose timelines allowing for 15-90 days to process export license applications where the French allow up to nine months.[33] The exact allowance should be discussed among the four agencies, but it should look to keep this limitation in line with its counterparts as to not further impede US commercial nuclear companies.

A more streamlined licensing process is only as good as the legislation that guides it. Again, we see the Atomic Energy Act (AEA) hindering commercial nuclear. The act does not specifically bar US companies from exporting, but it sets a high bar for approval, a bar that was set in the context of the Cold War at a time of high concern for nuclear proliferation. The US must recognize the times it now finds itself in, that of globalized nuclear markets, free flow of information, and stark competition from adversarial nations. The standards as set forth in section 123 of the AEA put a high stress on non-proliferation, meaning any nation that agrees to such terms will be severely limited in its ability to produce nuclear fuel. The agreement bars a partnering nation from enrichment or reprocessing of nuclear fuel without US approval. To compete with Russia and China, the US will need to reconsider its insistence on "gold standard" 123 agreements as non-allied competitors will not require as much of potential partners. Adjusting export standards to

[33] Ibid

be more align with other exporting nations should be given heavy consideration. Currently, the majority of nuclear exporting nations follow the guidelines for peaceful nuclear transfers as set by the Nuclear Suppliers Group in 1978. These guidelines are similar to US standards but offer more precise definition to its terms. This departure from US export guidelines should come as a welcomed change as the vagueness within the DOE's guidelines have been the cause of many of its inefficiencies.

Discussion

Proposed Policy Advantages Over Current Policy

It should be recognized that a noticeable shift in the current approach in policy to nuclear energy is underway. The Trump administration has been a verbal advocate of nuclear energy development to increase US competitiveness and has also requested increased funding for the DOE for such efforts. Additionally, the DOE has initiated programs and created working groups to evaluate current weaknesses to better convey to policy makers how to best move forward in nuclear energy. While these are important steps, much of what is being done or suggested falls short in its ability to effectively counter foreign efforts in two respects. Firstly, its focus is narrowed to advanced reactor technology. Although this is a critical aspect, it should be pursued in parallel with how to supply new reactors with needed materials and a plan to capitalize on new technology in the global market. This also does little to address the national security concerns for the current fleet of US reactors by overlooking nuclear fuel supply chain, a critical subset of the nuclear market. Secondly, the US has predominantly relied on increased funding indicating the assumption that an influx in funding will solve any woes ailing US nuclear

industry. Increased funding with lack of leadership and direction with little revision of existing policy is unlikely to result in success.

The policy approach proposed in this paper aims to solve those issues offering a more holistic approach with national security, collaboration, and competitiveness as its pillars. The differences between current policy and this proposal can be seen with the focus on securing the supply chain for nuclear material. This first step addresses a major national security vulnerability that current policy has done little to acknowledge let alone propose solutions for. With 20 percent of US baseload power coming from nuclear energy, adequate focus must be given to securing reliable access to the source of this energy. With a healthy industry to mine, convert, enrich, and fabricate nuclear fuel, the US will reduce the chances of a supply chain threat from Russia and its allies, as well as provide additional opportunity for material exports to emerging nuclear nations, further linking the US to new markets. Russia, and soon China, will offer comprehensive plans to construct reactors and provide materials to fuel and operate them. The US must follow suit highlighting the importance of establishing a strong front-end of the nuclear fuel cycle domestically which currently the US currently has no measures in place to achieve.

In the area of advancing nuclear reactor technology and the development of new generation IV reactors, current policy achieves its highest marks. It is clear the DOE and policy makers are aware of the need to be on the leading edge of reactor technology, but initiatives and additional funding falls short. Fourth generation reactors encompass a number of new design concepts. Small Modular Reactors (SMR) incorporate more traditional light water reactor operation designs that are scaled down, reducing risks of catastrophic accidents such as meltdowns as well as reducing production costs. Molten

Salt Reactors (MSR) are another design that have risen to prominence. MSR operation is fundamentally different than that of traditional light water reactors offering new fuel alternatives, greater safety, and less harmful nuclear waste. These two concepts alone will take decades to develop and deploy. China, for example, has been working on MSR development for nearly a decade and only nearing the construction process. Current policy is focusing on how to push development with the means we have domestically. This will only delay progress, utilizing the knowledge, funding, and manpower of our allies as this policy recommends will result in a net positive. With a US led coalition on nuclear energy, the US and its partners stand the best chance at not only developing reactor technology sooner for domestic use but also to be the first to market allowing western power to retake the lead on nuclear energy.

The importance of US commercial nuclear industry's ability to export is the final step in assuring US global leadership. Currently US policy on nuclear technology exports involves layers of bureaucratic oversight and approval, making it complex and difficult to navigate. Many US companies have expressed concern over its restrictive nature, in comparison to its competitors US companies often find themselves at a significant disadvantage to those nations with a more simplified approach. This proposal aims to alleviate much of that complexity. Reducing the convolutedness of the licensing and approval process alone should help the DOE and its counterparts expedite these requests. To ensure such timeliness, imposing deadlines for approval will keep the DOE on track. These deadlines will give US companies and prospective consumers a certain level of assurance their project will not experience cost increases due to delays caused by US regulation hindrances.

Evaluation and Shortcomings

Offering an advantage over current policy is important but should not be the only criteria to deem the proposed policy as advantageous. To determine its merit, we should look to the criteria as set by the methodology. Securing the needed fuel and material as well as the operational capability is the best option to enhance a nation's energy security and by association its national security. Establishing a uranium reserve to ensure raw material and the facilities needed domestically present the best option to reduce dependence on imports and vulnerabilities to the critical part of the process. The US has done this in the past with the uranium boom of the 1950s through the 60s but struggled to keep the industry alive without significant government intervention. While critics may excoriate these government subsidies, the 21st century global market for nuclear power is a much larger opportunity and the threat of climate change makes clean energy an urgent priority. The US will need to play a significant role in the initial propping up of the mining industry and front-end fuel processing. However, with global demand projected to rise, the industry is unlikely to continue depending on government intervention as it had in the past.

A successful policy will strike a safe balance between self-sufficiency and global cooperation. This proposal finds that balance by stressing a strong domestic fuel process while working to include allies in development of new technology. There is no doubt a lack of development would not be of any advantage to US energy security, however, a lack of access to nuclear fuel would present a far more imminent threat. New reactors are needed but will be far less useful if the fuel needed to operate them is restricted by foreign nations. With Russia and its allies controlling a substantial percentage of uranium production and export the importance of domestic production is unquestionable. The immediate threat of

fuel supply can be mitigated and the development of coalitions for new technology development will strengthen existing partnerships and open opportunities to forge new ones. The step may result in some difficulty as it relates to an export program for the US. The US cannot be the sole benefactor of the reactors if there are multiple nations involved with development and construction. However, this is not a barrier that should be difficult to overcome. The collaboration will be led by the US, allowing it to set the terms. These terms should be advantageous to the US in allowing for export but realistic in offering significant benefit to partnering nations. The significance of the terms set should not hold much significance as it is the goal of the proposal to increase US leadership and influence in nuclear energy. The proceeds are an added benefit, but the priority is to curb China and Russia efforts rather than increase profits.

The final criterion is also the most challenging for this proposed policy and will likely be a challenge for alternative proposals as well. Long term viability in nuclear energy does not have a clear path into the future. Therefore, developing ideal policies and actions for current times may be outdated in a decade. Though critical for current reactors and successfully offers a long-term solution to uranium reactors, as technology shifts to alternative fuels, such efforts will carry less meaning. This is not to say that much of what has been established cannot be retailored to accommodate new technology, but this will certainly require new policy when that time comes. The proposal does offer longevity in its call for collaboration and export. As we have seen with Russia, exporting reactors creates a link between importer and exporter which lasts beyond the construction of the reactor. It is a relationship that will last the duration of the reactor itself; for newer reactors, this could be anywhere from 80 to 100 years. Construction, operational assistance, fuel

supply and waste management will prove challenging for some nations. As a result, these nations will be heavily reliant on exporting nations. These relationships by their nature will need to stand the test of time, they will be binding and difficult to dismantle by changing administrations assuring their sustainability.

Conclusion

The US currently finds itself at a critical junction in nuclear power. The fact of domestic stagnation of the US nuclear industry and expertise is widely accepted and even applauded by some. If there is a continuation of turning a blind eye to the data and a failure to grasp the reality of the demands for clean, scalable energy as a result of climate change, US energy and national security will all be severely jeopardized. While there must be an openness from critics, it is the responsibility of proponents to clearly and rationally convey the benefits and urgency of increasing and advancing nuclear power. The scientific communities have always struggled with providing their findings and understandings to the lay person. It is vital that industry experts find a way to appeal to the emotional side of the argument. Experts cannot simply continue to publish information, but rather they must address the concerns of critics directly and show them the way forward that best alleviates these concerns.

While gaining the support of the popular vote would ease the process, it is the duty of policy makers to heed the advice of experts and to take the time to understand the information they are being given. If action is not taken and this stagnation continues through the next decade, the US will find itself in troubled waters both domestically and abroad. Until recently, the US has had little recourse for reversing the decline in its nuclear capacity or increasing its ability to influence nuclear dealings around the world. With the

massive rise in power of Russia and China in nuclear technology amidst rising tensions between the US and these two nations, it is more important now than ever to not cede any additional ground. The US has lost any monopoly it may have had in the past, but it cannot afford to lose its ability to influence the direction and utilization of nuclear power. Over the next decade, the US will likely lose its ability to restrict certain nations entirely from possessing nuclear energy with the arrival of two new nuclear exporters. If the ability to regulate who uses nuclear energy is lost, the need to retain an influence on how it is used becomes vital.

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Curriculum Vita

ERIC A. HENDERSON

Summary

Dedicated student with a passion for historical and current research with in-depth knowledge of government, international affairs, and national security. Analytical individual working in government administration at Federal Law Enforcement Agencies. I am interested in developing a career in national security while maintaining my interest in intelligence and energy security.

Education

Bachelor of Arts in History and Criminal Justice, *magna cum laude*

University at Albany, State University of New York – Albany, NY **May 2014**

Honors: Dean's List, Phi Alpha Theta – National History Honor Society

Research Experience

Hudson Institute

Center for Political-Military Analysis – Washington, D.C.

Research Intern **February 2018 – May 2018**

Remote-Research Intern **June 2015- November 2016**

- Conducted policy research on regional security issues including:
  - Effects of U.S. sanctions on Russian defense capabilities
  - Use of chemical weapons in Syrian Conflict
  - Russian-Pakistani-Indian military relations
- Wrote and edited reports submitted by other interns into one cohesive and concise final report
- Assisted in organizing and researching all available open-source information on Soviet perceptions of NATO exercises and nuclear capabilities during the Cold War